

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

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PROJECT INITIATION

Date: May 31, 1972

Project Title: Methods for Radar Detectability Reduction

Project No.: A-1421

Project Director: Mr. F. B. Dyer

(TS)

Sponsor: Naval Ship Systems Command; Washington, D.C.

Effective 5-15-72 * Estimated to run until: 12-30-72

Type Agreement: Contract No. N00024-72-C-1342 Amount: \$ 93,986.00

*Anticipatory Costs allowable from 2-1-72

Reports Required: Bi-monthly Progress Reports; Quarterly Fund Status Reports;
Final Technical Report

Sponsor Contact Person(s):

Technical Matters

Mr. Jesse Cox, SHIPS 398214
Naval Ship Systems Command
18th St. and Constitution Avenue NW
Washington, D.C. 20360

Contractual Matters

Mr. R. J. Whitcomb (ACO)
CNA Resident Representative
Campus

Defense Priority Rating: DO-A7 under DMS Reg. 1.

Assigned to Sensor Systems Division

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GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT TERMINATION

Date April 4, 1974

PROJECT TITLE: **Methods for Radar Detectability Reduction**

PROJECT NO: **A-1421**

PROJECT DIRECTOR: **Mr. F. B. Dyer**

SPONSOR: **Naval Ship Systems Command; Washington, D. C.**

TERMINATION EFFECTIVE: **2-28-74 (Contract Expiration)**

CHARGES SHOULD CLEAR ACCOUNTING BY: **2-28-74**

CONTRACT CLOSEOUT ITEMS REMAINING: **Final Invoice and Closing Documents
Final Report of Inventions
Government Property Inventory/Cert.
Classified Material Cert.**

SENSOR SYSTEMS DIVISION

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LIBRARY DOES NOT HAVE BI-MONTHLY PROGRESS LETTERS 1, 6-10.
TECHNICAL REPORT NO. 1.
FINAL REPORT.

THESE REPORTS ARE CLASSIFIED.



21 November 1972

Commander
Naval Electronic Systems Command
Washington, D. C. 20360

Attention: Mr. Jesse E. Cox
PME 398-R

Reference: Contract N00039-72-C-1342
Project Serial No. S3643, Task 12361

Subject: Bi-Monthly Progress Letter No. 2

Gentlemen:

The purpose of this letter is to summarize efforts undertaken under the subject contract during the period of 15 July through 15 September 1972.

The work has been directed into two primary tasks: (1) investigation of techniques for reduction of radar cross-section of selected masts and (2) field-testing of the J-Band radar and selected RCS reduction techniques.

The goals of the cross-section reduction work during this period have been to prepare for the at-sea testing of some of the concepts and to provide input to Micronetics in the preparation of covers for use in the field operation in October at the Torrey Pines Field Site. Predictions were prepared for wavelength, height, and size sensitivities for each of the masts to be viewed. Predictions were also prepared for guiding the at-sea tests of a series of test buoys. A total of ten different buoys were prepared for use at both the Boca Raton Field Site and at the Torrey Pines Site. A number of these buoys were observed with both the E/F- and I-Band radars at Boca Raton during the weeks of 21 and 28 August. Figures 1 through 3 show the general shapes which were tested. Figures 4 through 6 summarize some of the results of the observations. The actual measurements are compared to predictions (solid lines) for the specific buoys and radars. The spread of data are to be interpreted as peak-to-median measurements (each represents a summary of several data runs). The results are generally consistent with the predictions.

Additional measurements were made of sea return with all the radars, including the J-Band system. These data have been compared with the prediction model; the results are consistent with predictions. No buoy measurements were attempted with the J-Band system.


Contract N00039-72-C-1342
Bi-Monthly Progress Letter No. 2
Page 2


21 November 1972

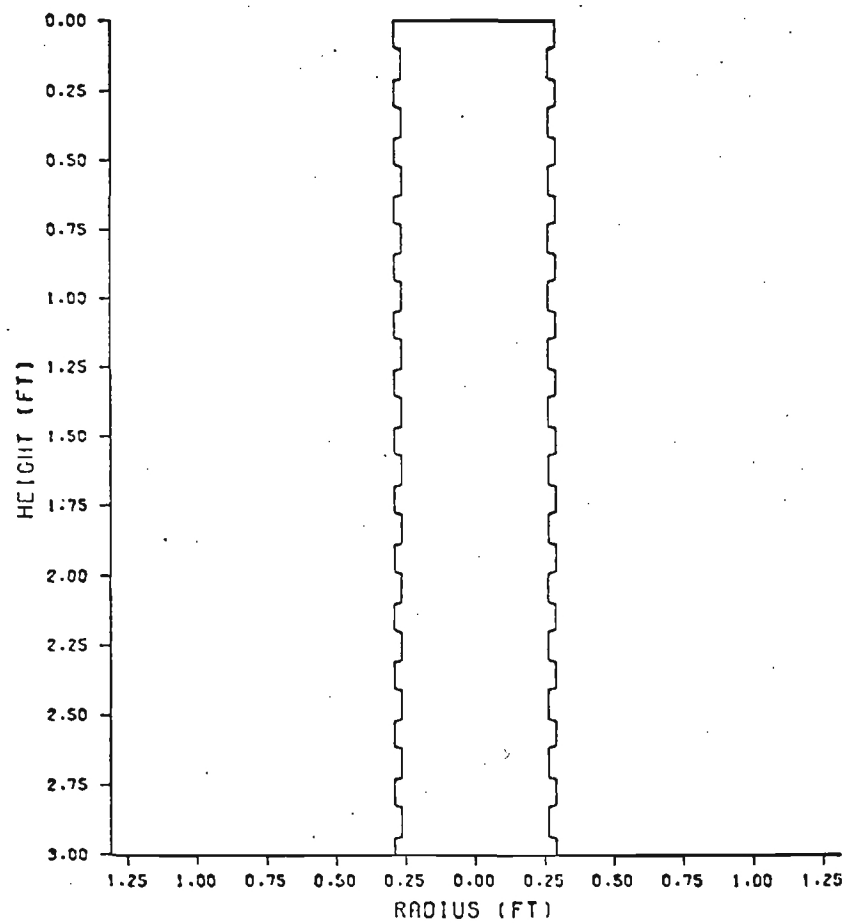
The program for the next report period will include preparation for and participation in the field operations at Torrey Pines.

Yours truly,

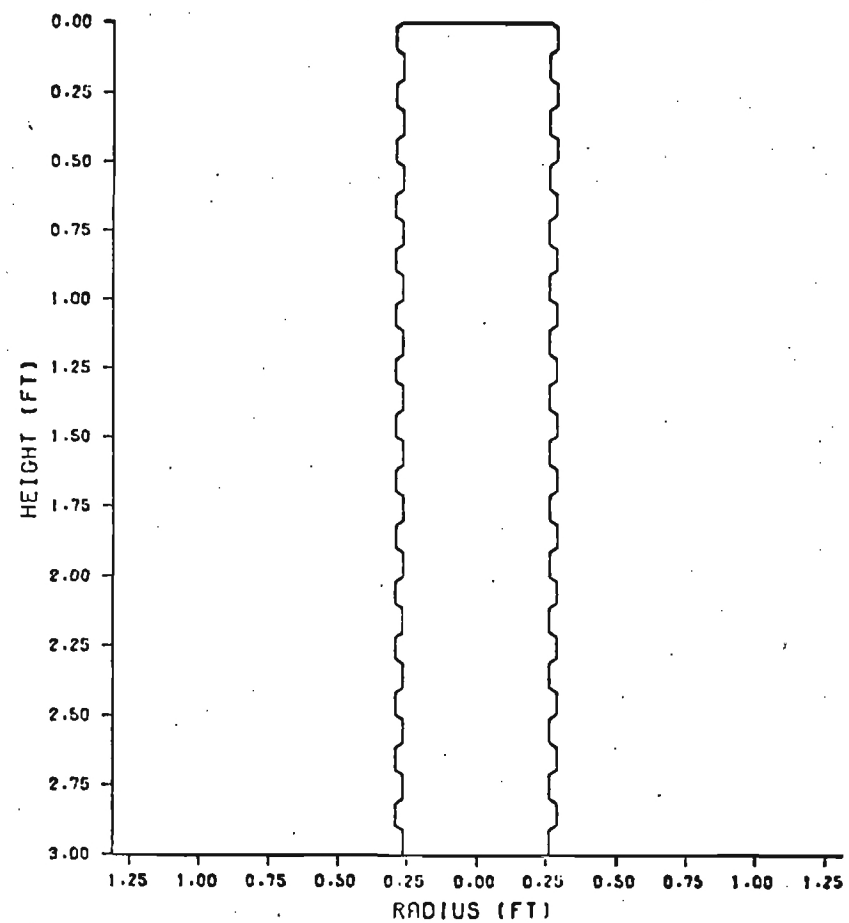
F. B. Dyer
Senior Research Physicist

Approved: 

R. M. Goodman, Jr.
Chief, Sensor Systems Division 



CON 51. TH = 3.00 FT.



CON 52. TH = 3.00 FT.

Figure 1. Test Shapes 51 and 52.

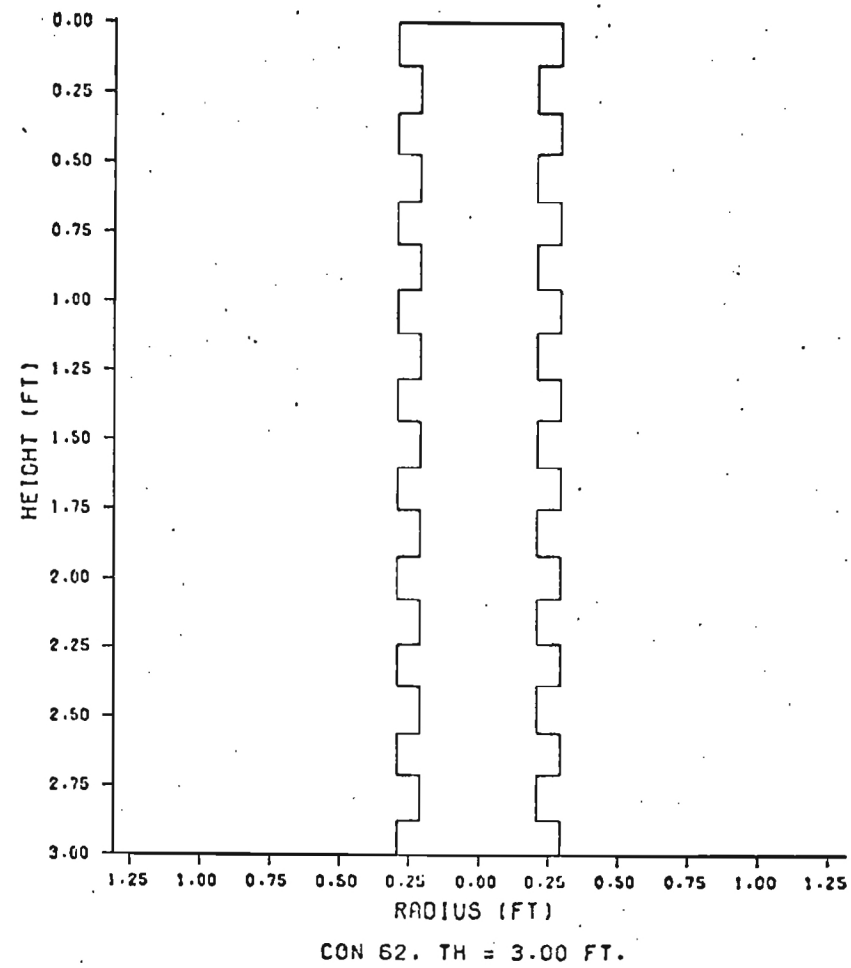
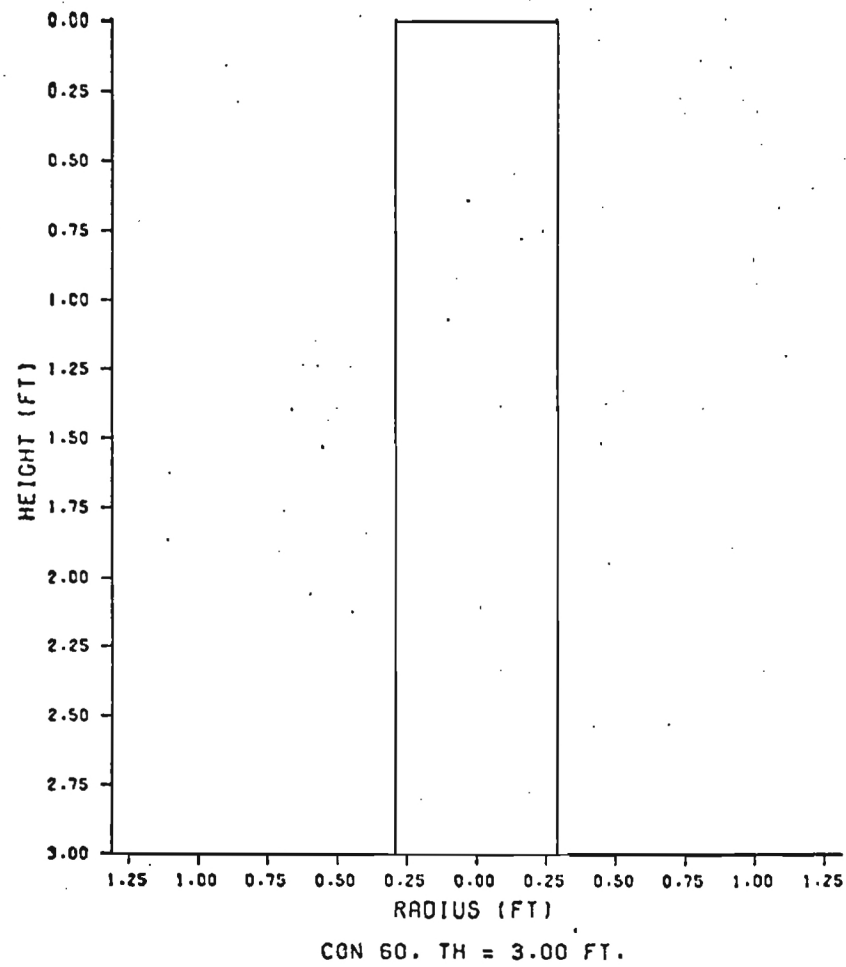
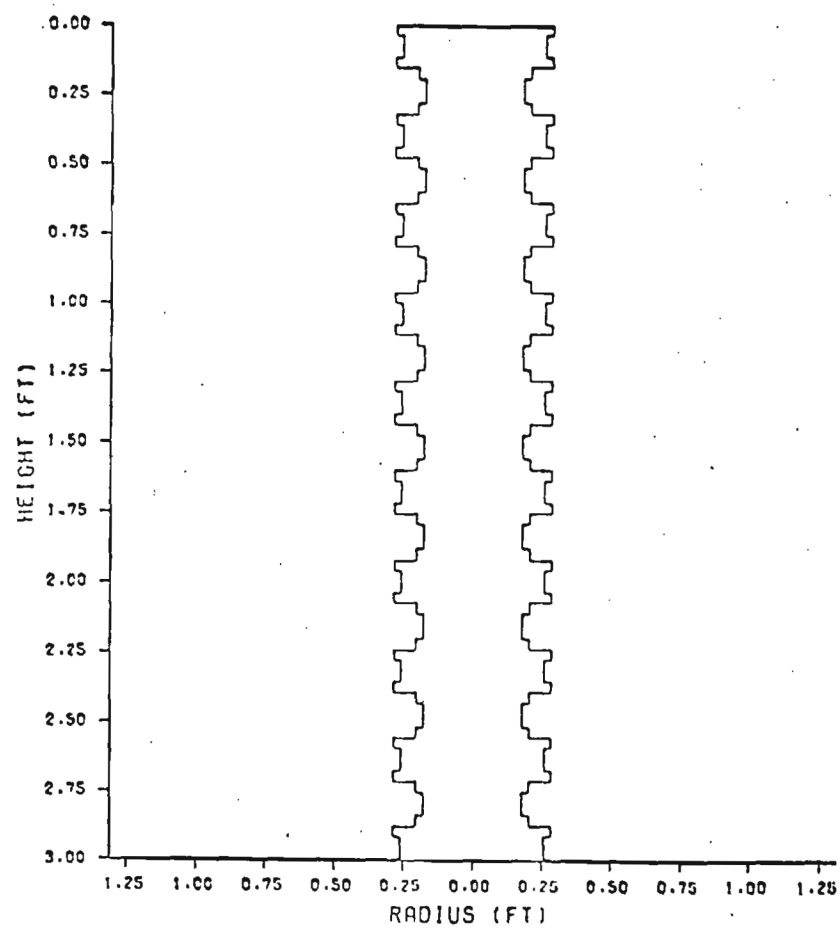


Figure 2. Test Shapes 60 and 62.



CON 63. TH = 3.00 FT.

Figure 3. Test Shape 63.

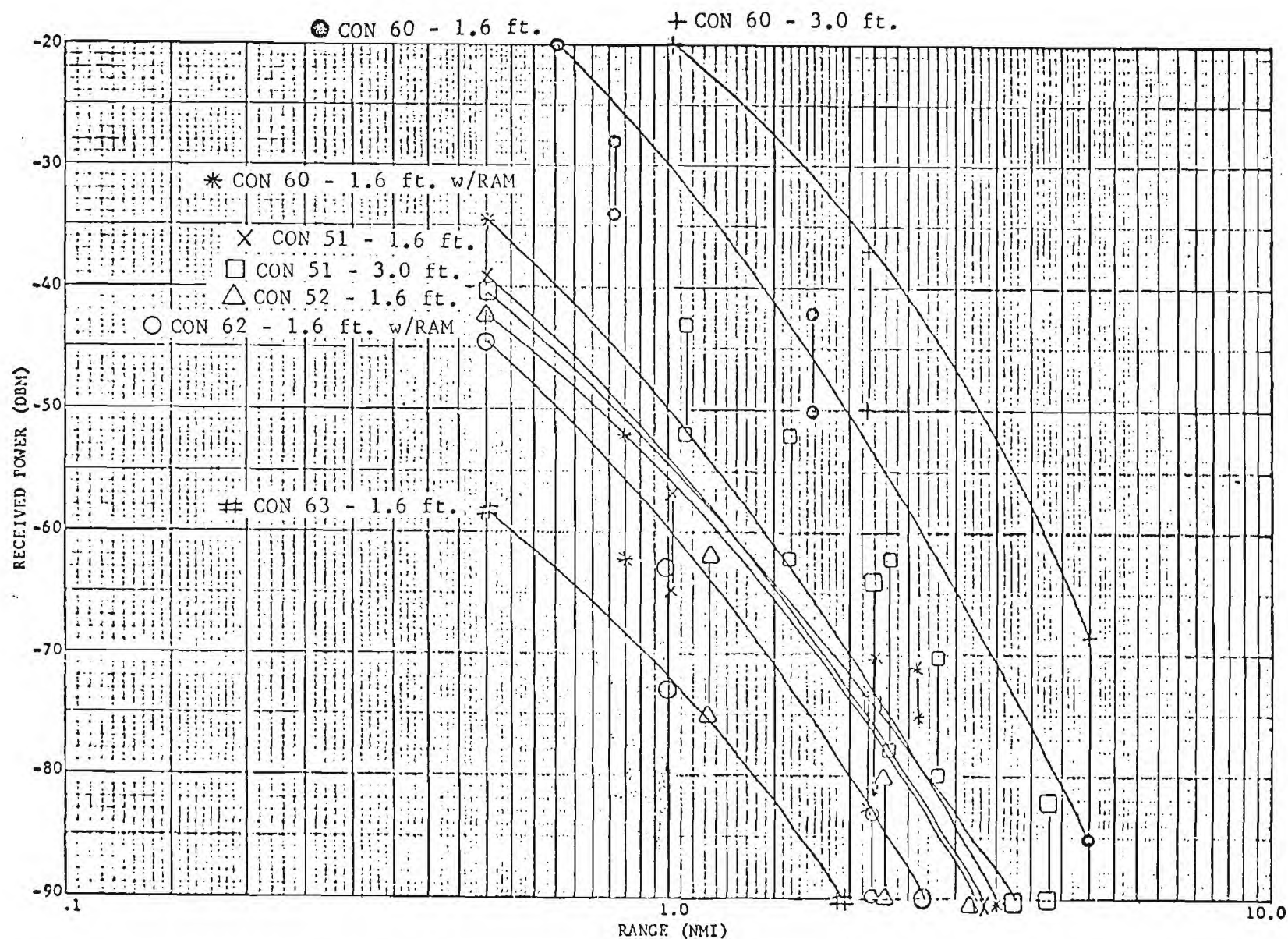


Figure 4. Summary of Predictions and Measurements for I-Band, Vertical Polarization, for Several Test Buoys. Boca Raton, 21-30 August 1972.

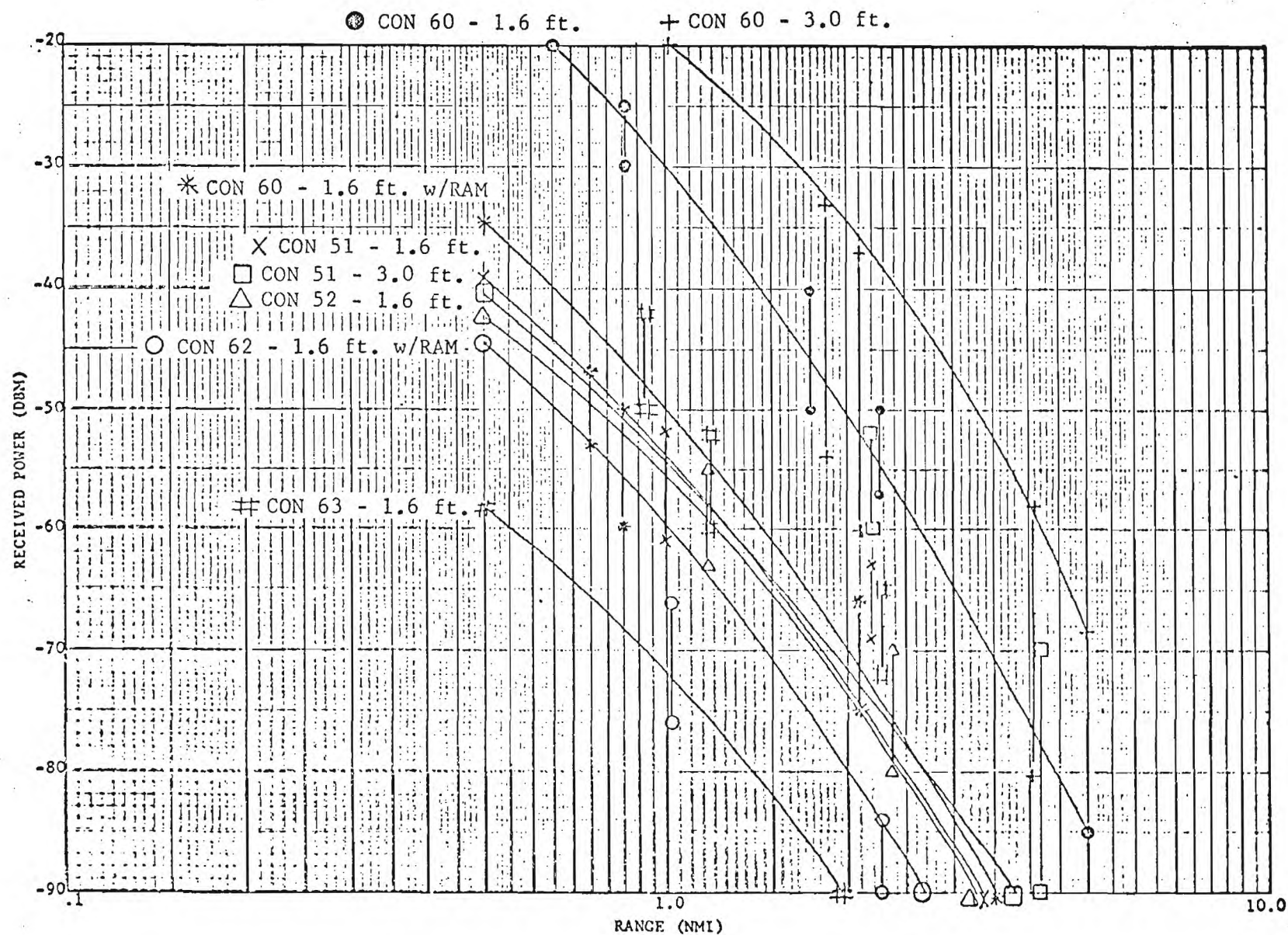


Figure 5. Summary of Predictions and Measurements for I-Band, Horizontal Polarization, for Several Test Buoys. Boca Raton, 21-30 August 1972.

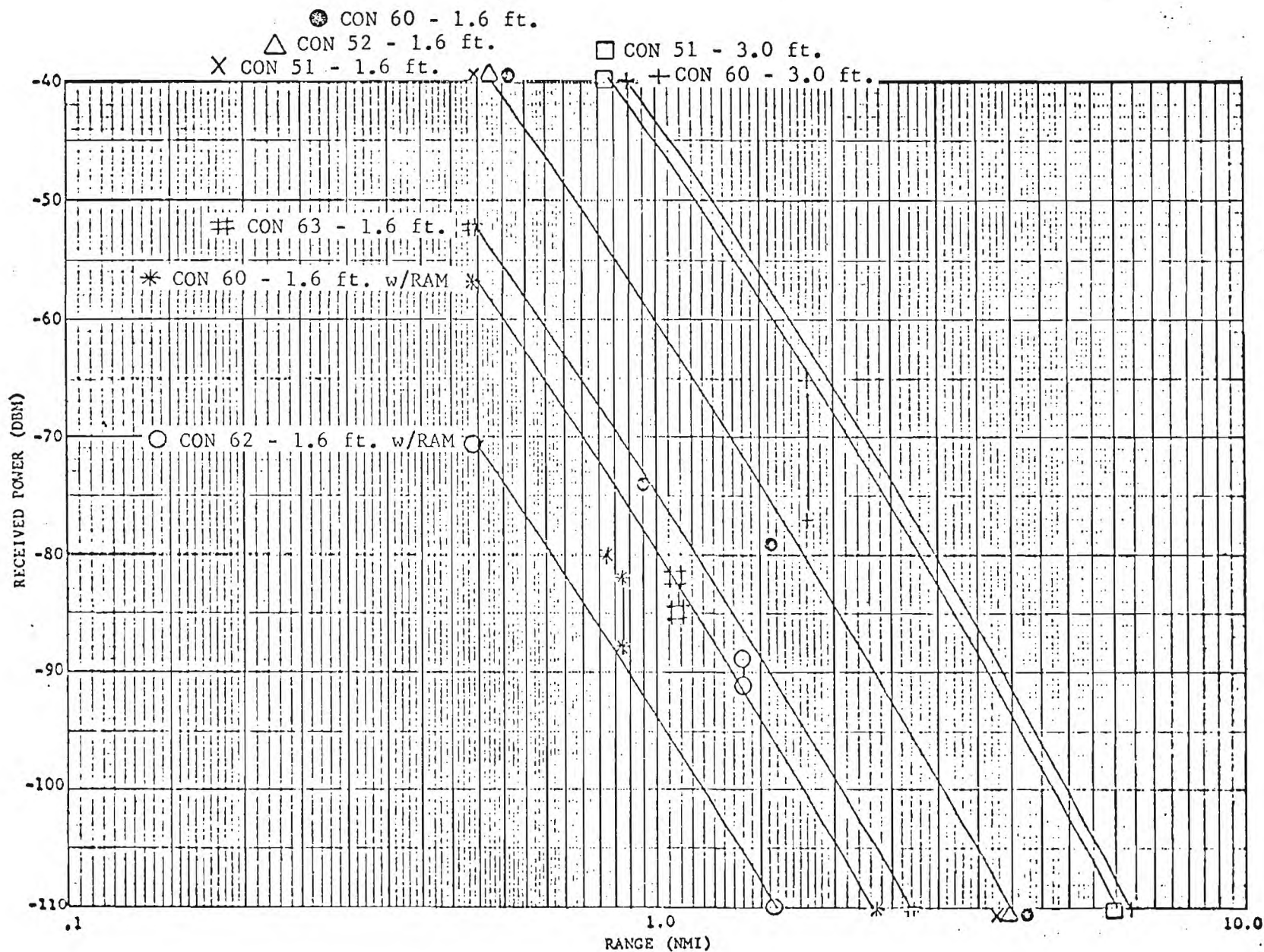


Figure 6. Summary of Predictions and Measurements for E/F-Band, Horizontal Polarization, for Several Test Buoys. Boca Raton, 21-30 August 1972.



GEORGIA INSTITUTE OF TECHNOLOGY
EXPERIMENT STATION 225 North Avenue, Northwest · Atlanta, Georgia 30332

A-1421

11 January 1973

Commander
Naval Electronic Systems Command
Washington, D. C. 20360

Attention: Mr. Jesse E. Cox
PME 198 R

Reference: Contract N00039-72-C-1342
Project Serial No. S3643, Task 12361

Subject: Bi-Monthly Progress Letter No. 3

Gentlemen:

The purpose of this letter is to summarize efforts undertaken under the subject contract during the period 15 September through 15 November 1972.

The work has been directed primarily to preparation for and support of the Stone Gate at-sea tests at Torrey Pines 25 - 26 October. Operations were conducted with the USS PINTADO (SSN-672) jointly with personnel from Micronetics, Inc., Airtronics, Inc., Qwest Research, and the U. S. Navy.

Additional tests were conducted at the Torrey Pines Site on 16 and 24 October with several special buoys. These tests were designed to demonstrate the potential of selected radar cross section reduction techniques. These test results are also to be compared with those obtained at the Boca Raton Site.

A preliminary analysis of data taken during the at-sea tests of 25 - 26 October was prepared. These results were reported to the Navy in the form of an interim report, "Preliminary Results of Project STONEGATE At Sea Tests 25 - 26 October 1972," published as Teledyne Micronetics Report R22-72.

A more detailed analysis of the collection of data from the 25 - 26 October tests was begun at Georgia Tech at the direction of Mr. Jesse Cox. This analysis is continuing.

The program for the next report period includes a continuation of the detailed analysis. Additional laboratory and theoretical efforts are planned in the area of radar cross section reduction techniques.

Yours truly,

F. B. Dyck
Senior Research Physicist

Approved.

R. M. Goodman, Jr.
Chief, Sensor Systems Division



GEORGIA INSTITUTE OF TECHNOLOGY

EXPERIMENT STATION 225 North Avenue, Northwest Atlanta, Georgia 30332

15 January 1973

Commander
Naval Electronic Systems Command
Washington, D. C. 20360

Attention: Mr. Jesse E. Cox
PME 198-R

Reference: Contract N00039-72-C-1342
Project Serial No. S3643, Task 12361

Subject: Bi-Monthly Progress Letter No. 4

Gentlemen:

The purpose of this letter is to summarize efforts undertaken under the subject contract during the period of 15 November 1972 through 15 January 1973.

The primary effort for this period has continued to be directed to the analysis and interpretation of the data obtained at the Torrey Pines Site in October. Data reduction is complete and the majority of the important computer predictions have been completed. Work is proceeding on the preparation of the summary report on operations with the USS PINTADO. The analysis, to date, essentially confirms the results of the "quick-look" analysis and report; however, there are many differences in detail in the data set.

Other effort has been directed to investigations of the reflectivity of radomes and dielectric materials. The work has included both experiment laboratory measurements and computer predictions. This work has also included additional measurements on various radar absorbing materials.

The program for the next reporting period includes completion of the summary report on the October operations and investigation of RCS reduction techniques.

Yours truly,

F. B. Dyer
Senior Research Physicist

Approved: _____

R. M. Goodman, Jr.
Chief, Sensor Systems Division



GEORGIA INSTITUTE OF TECHNOLOGY
EXPERIMENT STATION 225 North Avenue, Northwest Atlanta, Georgia 30332

5 March 1973

Commander
Naval Electronic Systems Command
Washington, D. C. 20360

Attention: Mr. Jesse E. Cox
PME 198-1

Reference: Contract N0039-72-C-1342
Project Serial No. S3643, Task 12361

Subject: Bi-Monthly Progress Letter No. 5

Gentlemen:

The purpose of this letter is to summarize efforts undertaken under the subject contract during the period of 15 January 1973 through 1 March 1973.

The primary effort for this period has continued to be directed to the analysis and interpretation of the data obtained at the Torrey Pines site in October. Analysis has centered about questions as to the actual cross-section reduction which has been demonstrated and to the effectiveness of the math model in predicting the radar cross-section of such complex shapes as the SUNDANCE. A detailed discussion of the analysis was conducted at Georgia Tech during the 20th and 21st of February with Messrs. Bob Nester and Leroy Hochhalter of Airtronics and Messrs. Roy Hughes and Warren Fey from Micronetics, Inc. The result of these discussions were presented to Mr. Jesse Cox at a planning session in Washington on the 22nd and the 23rd of February. As a result of the review of the draft of the summary report, additional analysis and data were recommended for inclusion in the final version of the report. These include buoy data from at-sea tests of 24 October and 5 December which can be used to substantiate the analysis of the operation with the USS PINTADO.

Preliminary summaries of the comparison between predictions and measurements for the buoy data from 24 October and 5 December are included here. The data are summarized in graphical form and show good correspondence between predictions of the math model and the at-sea measurements. The values for the various special buoys, particularly CON 60, CON 62 and CON 62P, do not correspond precisely to those values obtained at the earlier measurements at the Boca Raton site, principally because larger contributions from the float assemblies used with the buoys at the Torrey Pines site.

5 March 1973

Extensive checking of the calibration and run selection has been coordinated with Mr. Hughes, of Micronetics, in an attempt to insure that a reasonable and representative subset of the data are presented here. The data are plotted as peak return and average of the peaks in each case. Table I is a brief summary of the observed improvements from selected buoy data.

Also included in this report are data relating to the investigations of the radar cross section of antennas and radomes. Specifically included here is a comparison between the predictions of SEPO math model and measurements made on the compact reflectivity range for the new model 15 Omni antenna and radome assembly. Note that the reflectivity factors used are squared in the determination of cross-sections; therefore, for example, the factor of 0.1 is equivalent to a 20 dB reduction. The first graph is a comparison between predicted and measured cross-section for the unmodified antenna for several hypothetical values of reflectivity of the radome and the other graph is a similar comparison for which the metal portions of the assembly are covered with RAM. Both graphs are for I-band. Detailed investigations are continuing. It is anticipated that these investigations will provide a reasonable data base for use in the prediction of and in the development of cross-section reduction techniques for this antenna. This work is being augmented by cross checks with dielectric cylinders and with a inter-comparison of the effect of various cross-section reduction techniques.

The program for the next reporting period includes distribution of the summary report on the October operations. Investigations of cross-section reduction techniques, particularly as related to the antenna radome problem, and of the development of guidelines for field modification kits will continue. Effort will be directed to providing answers to the Action Items from the meeting of 23 February.

Yours truly,

F. B. Dyer^U
Senior Research Physicist

FBD:jel

Approved:

R. M. Goodman, Jr.
Chief, Sensor Systems Division

TABLE I Observed Improvements from
At-Sea Buoy Comparisons (Preliminary)

24 October 1972

	<u>Predicted</u>	<u>Actual</u>
F-Band		
CON 60 - CON 62P	17 dB @ 5 nmi 20 dB @ 10 nmi	17 dB @ 6.5 nmi 13 dB @ 5.9 nmi
I-Band		
CON 60 - CON 62P	27 dB @ 5 nmi 26 dB @ 10 nmi	26 dB @ 6.5 nmi 24 dB @ 5.9 nmi

5 December 1972

F-Band	6 dB @ 5 nmi	4 dB (comparing
CON 62 on #3 - CON 62 P on #3	7 dB @ 10 nmi	relation of different range points to prediction curves data is spread)
I-Band		
CON 62 on #3 - CON 62P on #3	1 dB @ 5 nmi -1 dB @ 10 nmi	0 dB (no close range comparison)
F-Band		
CON 62 on #3 - CON 62 on 6T	18 dB	15 dB (no direct range comparison)
I-Band		
CON 62 on #3 - CON 62 on 6T	12 dB	9 dB (no direct range comparison)

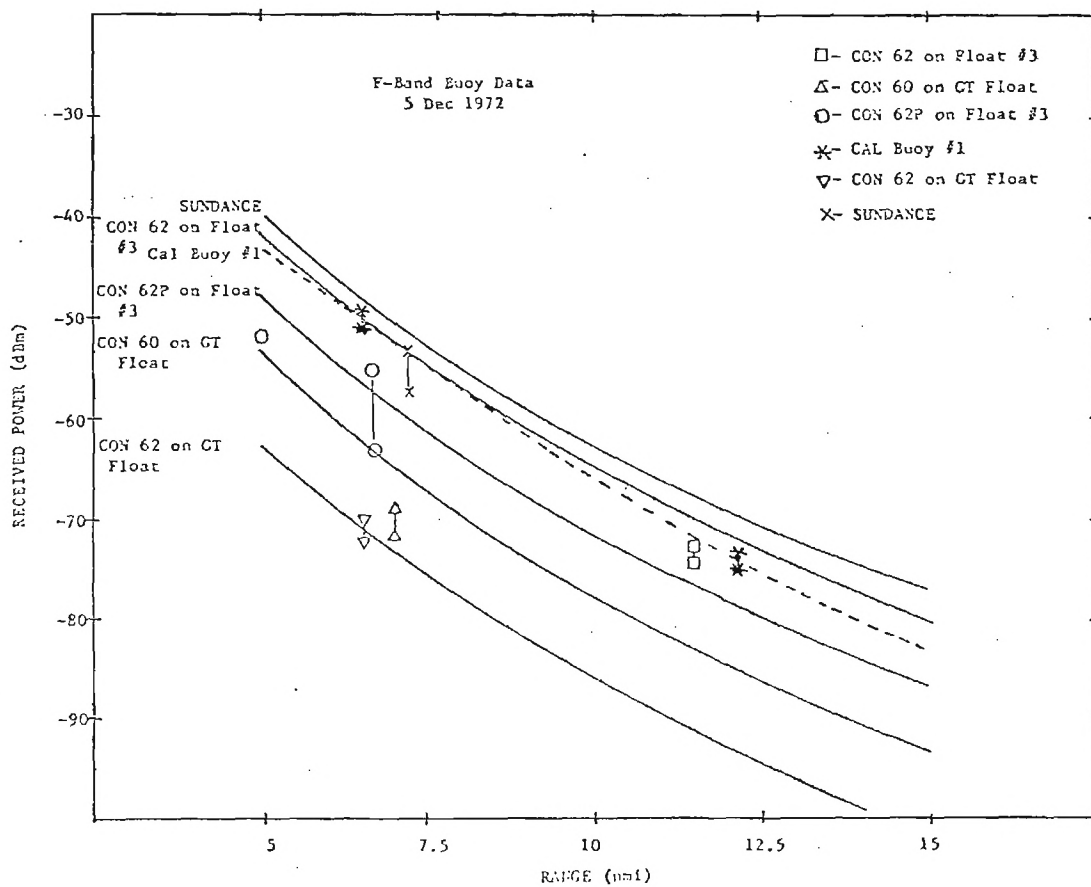
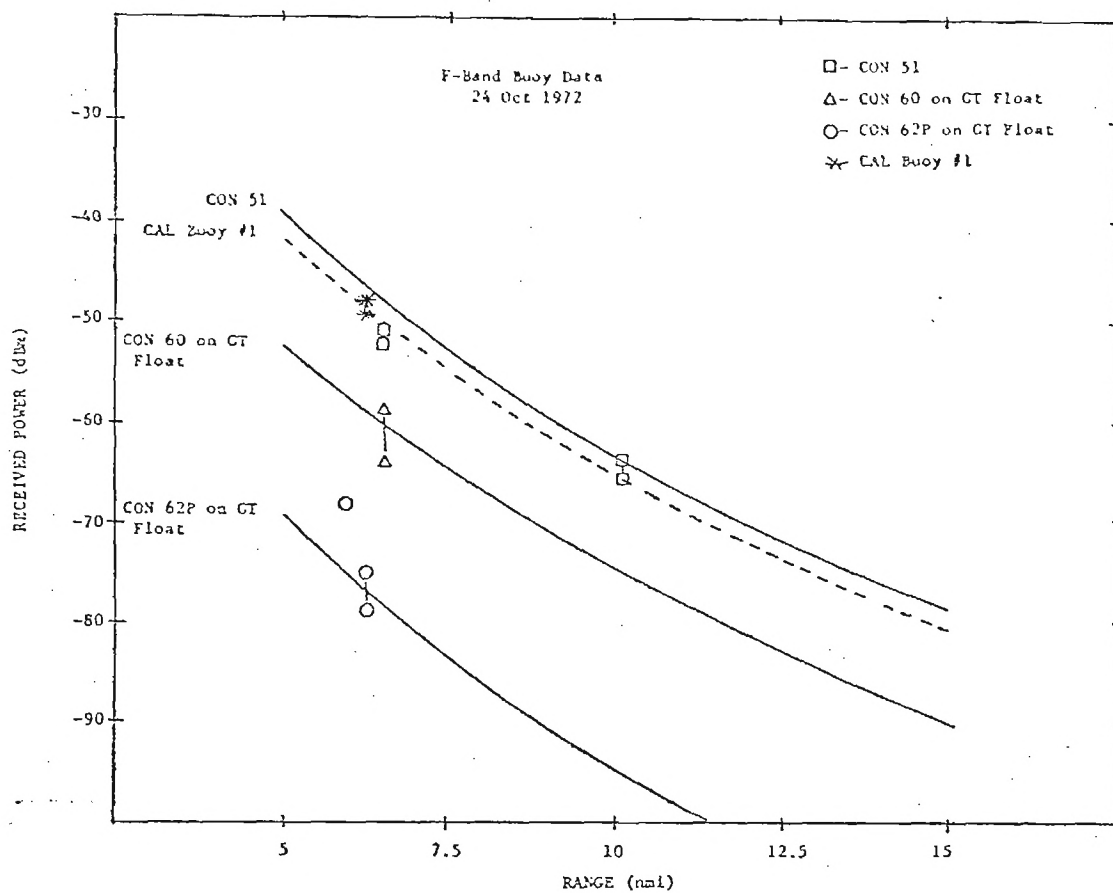


Figure 1. Comparison of F-Band Buoy Predictions and Data

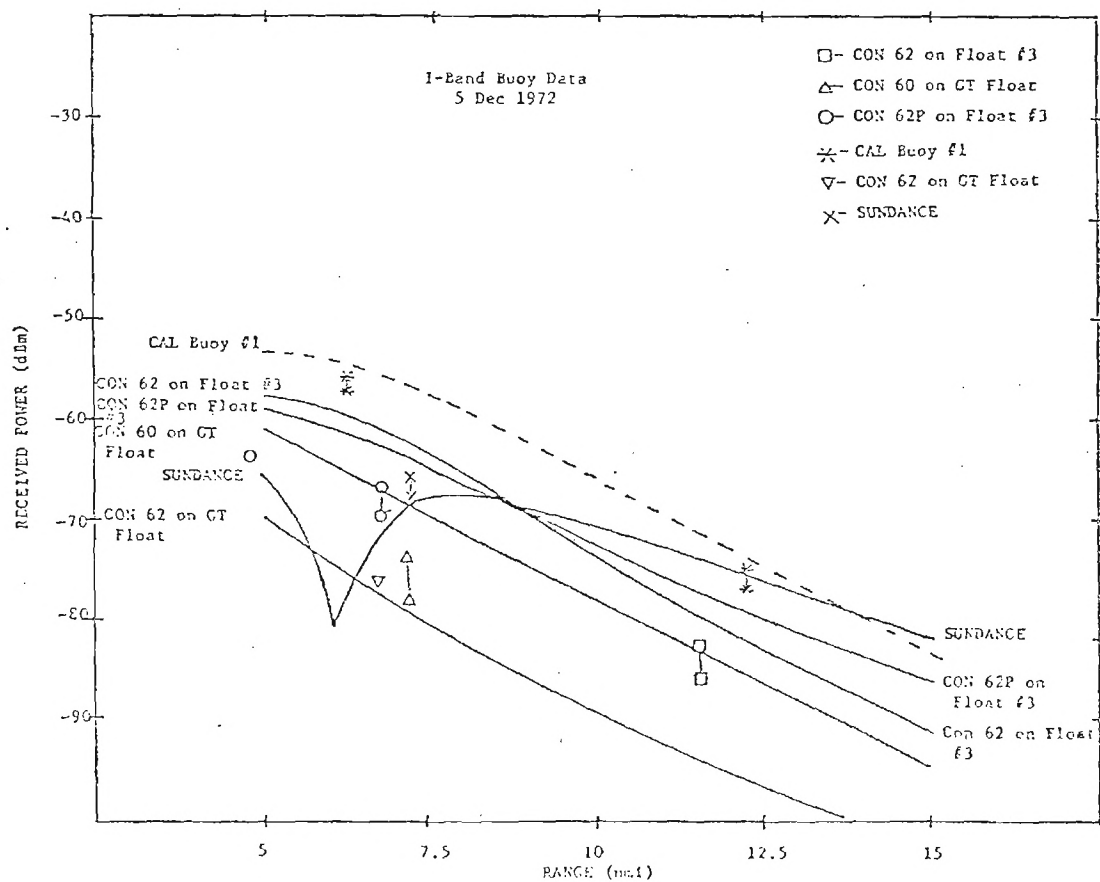
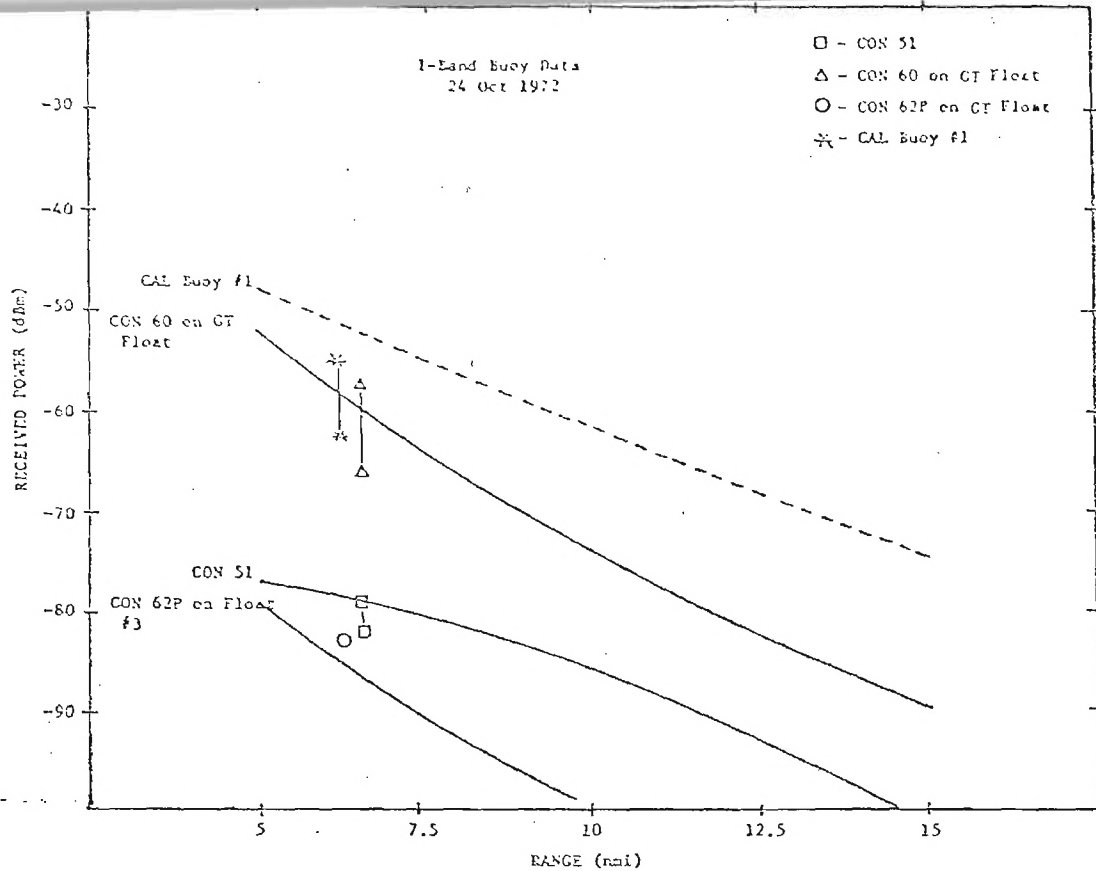


Figure 2. Comparison of I-Band Buoy Predictions and Data

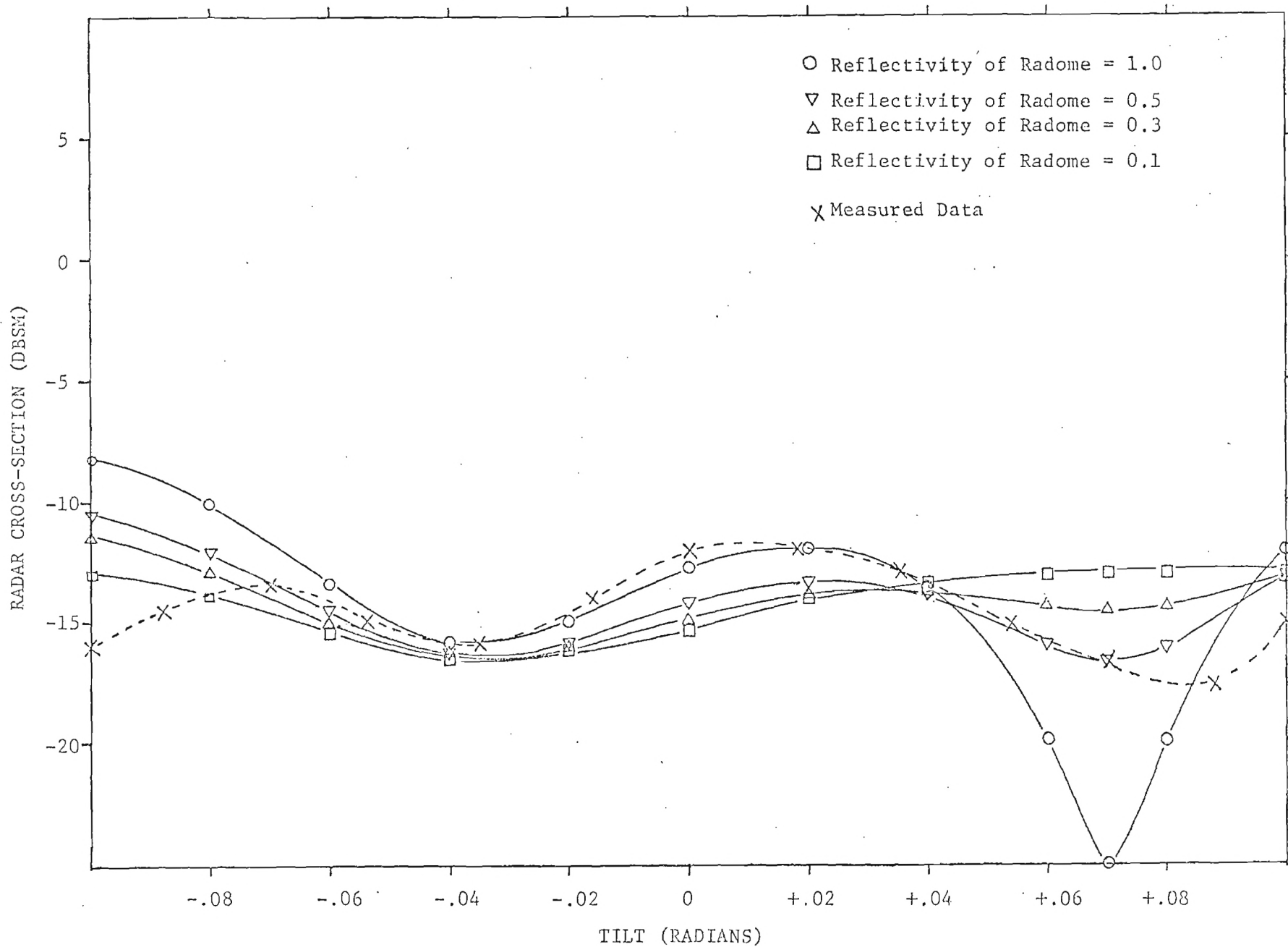


Figure 3. Comparison of SEPO Predictions and Measured Data for Untreated Type 15 Omni Antenna Assembly

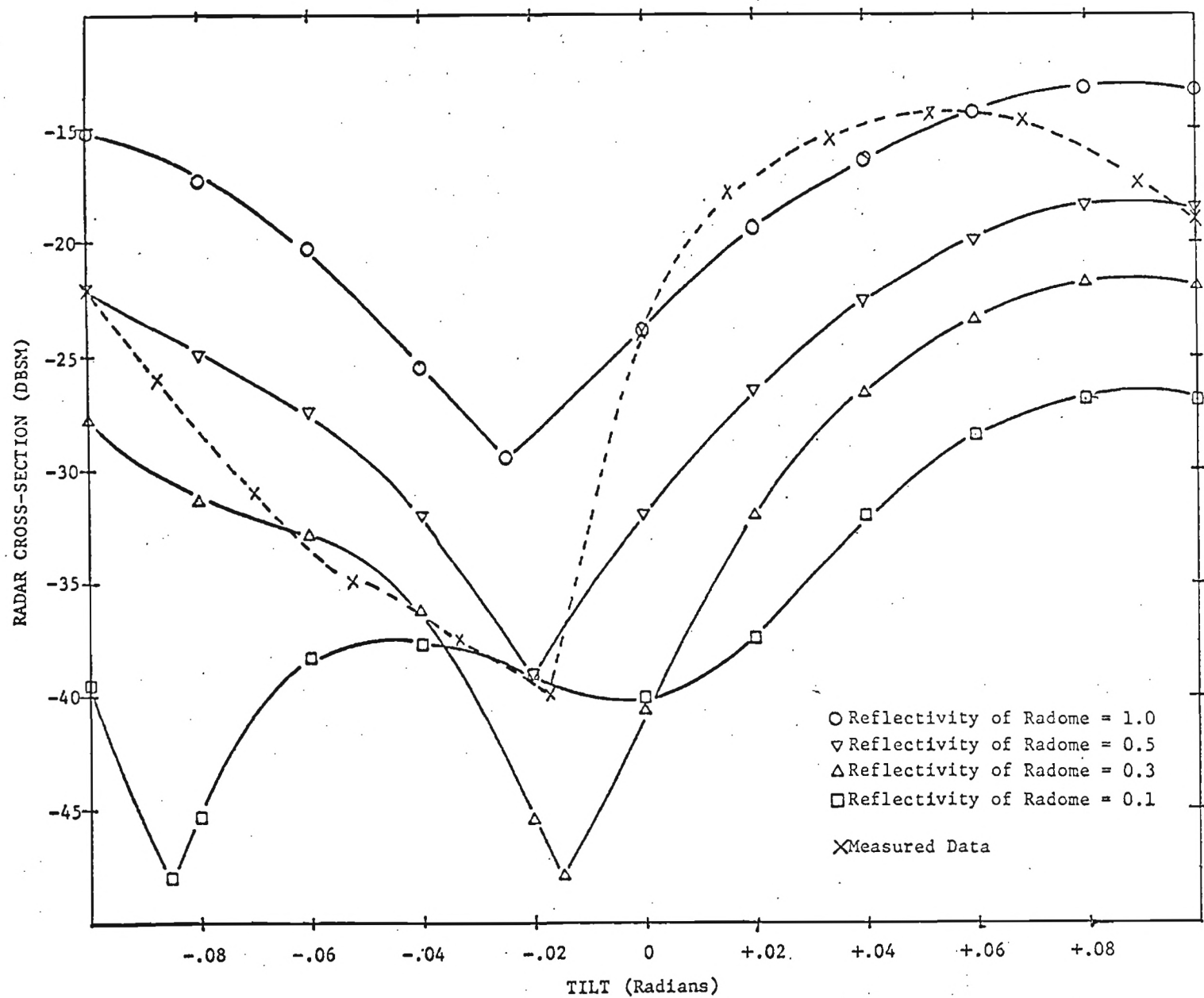


Figure 4. Comparison of SEPO Predictions and Measured Data for Partially Treated Type 15 Omni Antenna Assembly